The Puzzling Problem of Sealy and Leaky Faults

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Abstract

Abu Dhabi onshore Anticlinal Fields are showing the presence of several leads/prospects with a significant amount of hydrocarbon accumulations, where the faults provide the critical up-dip closure. The classical approach based on the construction of a deterministic juxtaposition and Shale gouge ratio analysis will not work in Abu Dhabi areas, as most of the section is mainly consisting of carbonates and also the faulting history is mainly overcomes by strike-slip movement, where the vertical offset along the faults are minimum. Therefore, implementing a new approach based on construction of a 3Dmodel, complemented with modeled pressure data and geomechanical considerations is a must.

In the exploration stage, large uncertainty of the risk analysis is mainly due to the deterministic models, that not accounting for the large variation in parameters that could take place and would influence the total fault seal risk assessment. Hence, the results offer useful insights in the main factors and highlights how the system should behave, but it lacks a comprehensive risk evaluation, in terms of uncertainty ranges and sensitivities. As a result the explorationist has no indication how “uncertain” the results are. Alternatively or complementary, a probabilistic assessment would give a better understanding of the uncertainty and risks involved.

The sealing behavior of faults is known to control aspects of hydrocarbon migration and reservoir distribution in space and time. Fault planes can be sealing and prevent flow of fluids in one time and be leaking in another time. It can be sealing for oil and leaking for gas/oil or it can be sealing at one horizon and leaking at another horizon. A Fault seal Study provide a tool for assessing the risk of fault seal in undrilled prospects. A full study requires an integrated approach based on statistical analysis of a database of sealing and non-sealing faults to solving fault seal issues, which involves a combination of: Detailed microstructural, geometries and petrophysical property analysis of fault rocks (fault zone poroperm histories, sealing mechanisms, sealing capacities & stability and the timing of fault activity during the burial history) in addition to the geomechanical modeling aspects with the characterization of fault array geometry, population, distribution of sub-seismic faults from wells, cores and outcrop data and an evaluation of the seismic scale fault array attributes.

Faulting mechanisms in Abu Dhabi petroleum system have complicated movement histories involving numerous periods of reactivation and, in some cases multiple reversals of fault-movement direction. Therefore, to fully assess fault-seal potential it is necessary to examine the evolution of faults through time and the stress history, in addition to fault characterization, population, sealing criteria, and fault geometry/orientation.

In Abu Dhabi fields, well data, 3D seismic data, and advanced interpretation tools can make it possible to accurately characterize the geometry/distribution and kinematics of faults, the in situ pressure differences across them and the possible compartmentalization.